Building Background Knowledge

Improving student achievement through wide reading

Douglas Fisher, Donna Ross, and Maria Grant

Too often, students enter our classrooms with insufficient knowledge of physical science. As a result, they have a difficult time understanding content in texts, lectures, and laboratory activities. This lack of background knowledge can have an impact on their ability to ask questions and wonder—both key components of inquiry.

The solution, in many schools, is comprehension strategy instruction, in which students are taught how to use cognitive processes to understand texts. Literacy experts often recommend that science teachers focus on comprehension tools, such as visualizing, predicting, summarizing, questioning, making connections, and inferring. We argue, however, that without sufficient background knowledge, none of these tools will be effective.

In this article, we demonstrate the impact that building background knowledge through wide reading can have on student achievement. With this method, students read a selection of texts on a given subject. We identify a number of reasons why wide reading is not commonly used in the classroom and how to address those concerns.

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Developing background: Direct and indirect experiences

Students can develop background knowledge through both direct and indirect experiences (Marzano 2004). Direct experiences include activities such as field trips and labs. These are powerful ways to enhance student understanding. Consider, for example, the impact of visiting a space museum or a science center. We recently had the opportunity to take our ninth-grade students to see a museum exhibit focused on water. The experience provided a foundation for understanding this natural resource and its importance in climate change. By the end of the day, our students had come to understand the formula at the center of the exhibit: using water = using energy = carbon dioxide (CO_2) emissions = climate change. Direct experience with the exhibit brought this idea home for our students.

However, field trips and labs are time-consuming and costly. Although they are excellent ways to build background knowledge, they are also not available for every lesson we teach, and they often do not provide the specifics students must know and understand to be successful in the physical sciences.

So instead, we rely on indirect experiences to build students' background knowledge. Wide reading—in which students independently read books, magazines, or other available materials for an extended period of time—can be an effective indirect way to build background knowledge. Unlike free, voluntary reading, this method is focused on a specific topic, such as wave motion or the rock cycle. Students read materials at their own reading level—an important and often overlooked aspect of independent reading. To be effective, students must understand what they are reading so they can connect new vocabulary and ideas. Finally, they need time every day to develop a habit of reading for information in their science classes. This mirrors the lives of scientists, who read widely on nearly a daily basis, in journals, websites, field notes, and the like.

Measuring student achievement

While we know that building background knowledge is important for understanding content, we wanted to find out whether focusing on this aspect of teaching would improve student achievement. To test our hypothesis, we selected one section of ninth-grade Earth science students for an intervention unit on plate tectonics; students in other sections of the course served as the control group.

We also tested one class of 11th-grade physics students. However, because of the small number of students enrolled in the class, we compared their scores on one intervention unit—on waves—with scores in other assessed areas on

the comprehensive physics exam, instead of assigning a control group.

During these units of investigation, students in the intervention classrooms read widely for 10–12 minutes of class time each day. This required a shifting in other activities, such as lectures, discussions, and textbook reading. Class time was no longer than usual during the investigation, but we did adjust the schedule in the intervention classes to provide time for wide reading.

For the 10–12 minutes devoted to reading, students selected materials from a collection we had assembled. To ensure that students chose texts at the appropriate reading level, we offered a wide range of materials—from picture books to internet articles to primary source texts. All of the readings related to the content and the National Science Education Standards (NRC 1996) being taught and assessed in the intervention unit. Students were encouraged to make a different selection if they were getting stuck on a specific reading and reminded that well-chosen selections could help them build a foundation for new learning in the content area. This concept is founded in research surrounding schema

FIGURE 1

Sample Earth science texts.

- *If You Lived at the Time of the Great San Francisco Earthquake* (Levine 1992)
- *Into the Volcano: A Volcano Researcher at Work* (O'Meara 2007)
- *Earthquakes: Witness to Disaster* (Fradin and Fradin 2008)
- *Shock Waves Through Los Angeles: The Northridge Earthquake* (Vogel 1996)
- *Volcano: The Eruption and Healing of Mount St. Helens* (Lauber 1993)
- *Volcanoes & Earthquakes* (Van Rose 2004)

theory, which views knowledge as an internal, organized domain upon which extended, deeper understandings may be developed (McNeil 1987; Stahl 1999). Some of the texts available to the Earth science students in the plate tectonics unit can be found in Figure 1.

Assessing the impact of wide reading

At the end of the intervention units, students' progress was evaluated using both the textbook's unit test and the California Standards Test. The results of both the textbook and state tests suggest that building background knowledge through wide reading improves student achievement.

For example, on the state test, the ninth-grade Earth science students outperformed their peers in the control group on questions related to the intervention unit. Of the 14 Earth science questions on the California Standards Test, the ninth-grade students who read widely averaged 86% correct, compared to 59% correct in the control class; the results were statistically significant ($t = 8.05$, $p < .001$). The effect size (a measure of the strength of the relationship between two variables, in this case wide reading and test scores) for the intervention was 0.73—meaning that it was moderately effective.

It is also important to note that there were no significant differences between the groups in the previous unit of study (astronomy). This suggests that the two groups were performing equally well in the class in its traditional structure and that wide reading did improve student achievement—as seen in the Earth science portion of the test.

The results for the physics class are similar to those achieved by the Earth science students. We assessed the results for this intervention unit by comparing students' scores on the waves unit—the intervention unit—with their scores in other areas. Although there were only 12 questions on waves on the California Standards Test, students performed better on this section of the exam than any other area—including sections on conservation of energy and momentum, heat and thermodynamics, motion and forces, and electrical and magnetic phenomena. Again, it seems that the background knowledge students gained through wide reading helped them integrate information from lectures and labs into their overall understanding.

When we asked one of our ninth-grade students why she thought she did so well on the unit test for plate tectonics, she said, "I just knew more about it." To probe a bit deeper, we asked how she learned so much about this particular topic. Her answer focused on reading:

> Well, it was just easier. During seminar, I got to read this great book with pictures of the ring of fire. I didn't get it at first, you know, why they say "ring." But the book talked about the features of the land where most volcanoes happen. Then I wanted to learn more about volcanoes.
>
> The next book I read was about scientists who study volcanoes. They walk in lava tunnels to learn more about the flow. They also can predict when volcanoes will erupt. I also read about the [Los Angeles] earthquake. I didn't know that volcanoes and earthquakes were related… because of the plates below the surface of the Earth.

As the student continued talking, she regularly referenced books that she read during the seminar—the portion of class devoted to wide reading. Her comments highlighted the lasting impact that wide reading had on her understanding.

Challenges and opportunities

It is clear that wide reading builds background knowledge and that this knowledge is critical to understanding physical science. Why then, is this method not used in more classrooms, and why had we never used it before? We identified several common reasons for why this is so:

1. *Students should not read "easy" books in high school.* As high school teachers, we have always thought that students need to read difficult books. However, we have come to understand that students cannot learn from books they cannot read. When we keep the topic constant and vary the level of reading materials, we have found that students achieve at higher levels.
2. *Finding appropriate books is difficult.* In part, the internet has helped solve this issue. An "advanced search" on internet bookselling sites using keywords and age ranges often results in lists of books that are appropriate for the classroom. The National Science Teachers Association (NSTA) offers two valuable online resources: NSTA Recommends and the Science Store (see "NSTA connections"). Both websites offer free book reviews searchable

by topic and grade level. The school librarian is a great resource as well.

3. *Paying for all of these reading materials is challenging.* With wide reading, one of the issues that remains for us is cost. We have considered a number of alternative classroom structures, such as having half of the students read while the others work collaboratively, and then switching. Again, the internet is helpful—we print appropriate readings, while being careful to reference sources and not print copyright-restricted material. We have also argued for a larger budget, making the claim that students need access to these materials if they are going to master the content. For now, it is a matter of priority. If school leaders want to ensure that students understand the content, we have to work together to find the funds to help students read widely on a daily basis.
4. *Storing books is problematic.* Once we are finished with a unit, it is always difficult to find space to store that unit's books. Because we do not have extra storage space, we organize our reading materials by theme and store them in boxes in our school's textbook room. This ensures that fewer books are lost as a result of being on classroom shelves throughout the year, and that we do not use classroom space that is already in short supply. Online book cataloguing can also help manage these resources (Cavanaugh 2009).

Conclusion

Although wide reading seems to aid students' learning, it is not the only answer in building background knowledge. Students also need quality instruction, opportunities for inquiry, and extensive lab experiences to consolidate their understanding of physical science. Combining these elements enhances background knowledge, and we think this is the best way to ensure high achievement. Our experience and test results suggest that wide reading on a daily basis is an effective way to promote student success. ■

Douglas Fisher (dfisher@hshmc.org) *is a teacher and coach at Health Sciences High and Middle College School in San Diego, California; Donna Ross* (dlross@mail.sdsu.edu) *is a professor at San Diego State University and science teacher at Health Sciences High and Middle College School in San Diego, California; Maria Grant* (mgrant@fullerton.edu) *is a professor at California State University, Fullerton in California.*

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References

Cavanaugh, T. 2009. Idea bank: Start a classroom library! *The Science Teacher* 76 (5): 60–63.

Fradin, J., and D. Fradin. 2008. *Earthquakes: Witness to disaster*. Washington, DC: National Geographic.

Lauber, P. 1993. *Volcano: The eruption and healing of Mount St. Helens*. New York: Aladdin.

Levine, E. 1992. *If you lived at the time of the great San Francisco earthquake*. New York: Scholastic.

Marzano, R.J. 2004. *Building background knowledge for academic achievement: Research on what works in schools.* Alexandria, VA: Association for Supervision and Curriculum Development.

McNeil, J.D. 1987. *Reading comprehension: New directions for classroom practice.* 2nd ed. Glenview, IL: Scott Foresman.

National Research Council (NRC). 1996. National science education standards. Washington, DC: National Academies Press.

O'Meara, D. 2007. *Into the volcano: A volcano researcher at work*. Tonawanda, NY: Kids Can Press.

Stahl, S.A. 1999. *Vocabulary development.* Cambridge, MA: Brookline Books.

Van Rose, S. 2004. *Volcanoes & earthquakes*. New York: DK Children.

Vogel, C.G. 1996. *Shock waves through Los Angeles: The Northridge earthquake*. New York: Little, Brown.